

PRELIMINARY DATA SUMMARY

February 1991

U.S. Army Engineer Waterways Experiment Station
Coastal Engineering Research Center
Field Research Facility
Duck, North Carolina

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CERC Field Research Facility
Duck, North Carolina

This report provides a summary of basic oceanographic, meteorological and bottom profile data for the month. The data were obtained as part of the Measurements and Analysis work units at the U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's Field Research Facility (FRF) in Duck, North Carolina. The FRF staff collected and analyzed these data. These summaries are intended to make the data readily available to all FRF users, and comments on their content and usefulness are invited.

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PART I: INTRODUCTION

The U.S. Army Engineer Waterways Experiment Station, Coastal Engineering Research Center's (CERC's) Field Research Facility (FRF) is located on the Outer Banks of North Carolina, near the village of Duck (Figure 1).

The FRF research program provides a means for obtaining high-quality field data, particularly during storms, in support of the U.S. Army Corps of Engineers' coastal engineering research missions. The research pier is a reinforced concrete structure supported on 0.9-m-diam steel piles spaced 12.2 m apart along the pier's length and 4.6 m apart across the width. The pier deck is 6.1 m wide and extends from behind the duneline to about the 6-m water depth contour at a height of 7.6 m above the National Geodetic Vertical Datum (NGVD). In addition, a main building contains offices, an instrument repair shop, and a data acquisition room.

One of the responsibilities of the FRF research program is the collection, analysis and dissemination of data on local oceanographic and meteorological conditions. Bottom profiles along both sides of the pier and periodic bathymetric surveys are also performed.

This summary is intended to provide basic data as soon as possible after they are obtained. Questions and/or comments concerning the data may be directed to Mr. Michael W. Leffler at (919) 261-3511.

Part II presents the meteorological data; Parts III through VI present oceanographic data; Part VII presents nearshore profiles and bathymetry; and Part VIII, if included, documents special events that occurred at the FRF during the month.

Table 1 is a list of instruments used, their operational status during the month, and the data collection status. Figure 2 identifies the location of the instruments. The water depths at the wave gages and current meters vary and may be determined from information contained in Figure 7. Other installation information is contained in Table 1.

Times given in the report, unless otherwise specified, are referenced to eastern standard time (EST).

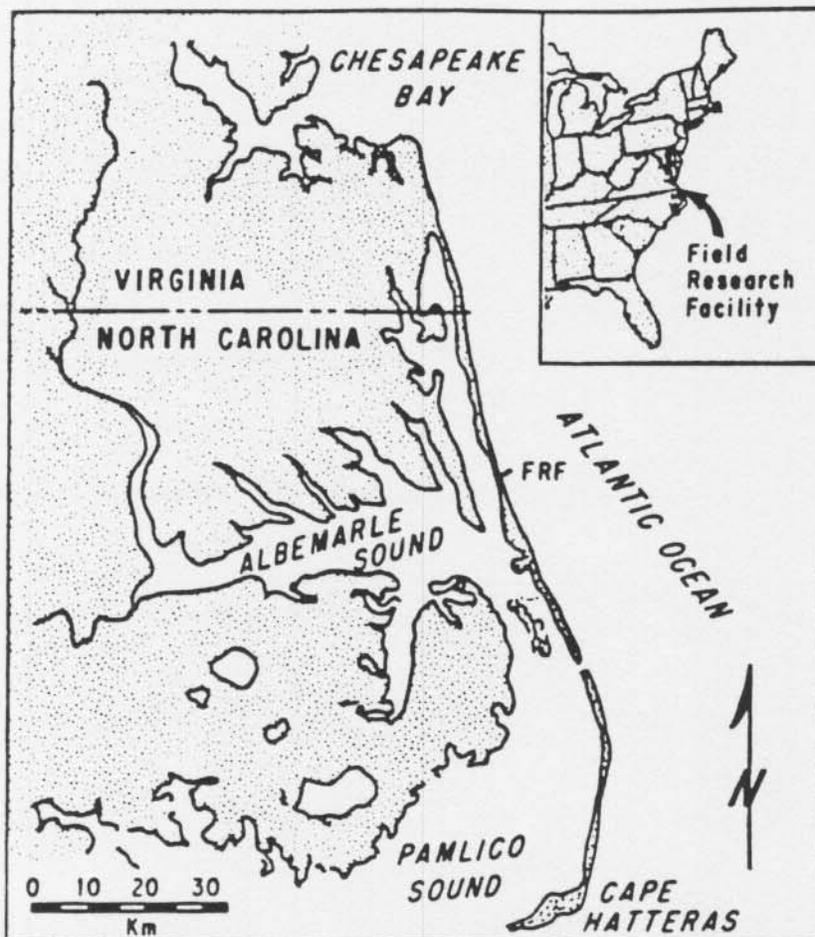


Figure 1. FRF location map

Table 1: Instrument Status/Data Availability

FEB 1991

Gage ID	Description/Remarks	Depth at Sensor		Day of the month																											
				1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8	9	0	1	2	3	4	5	6	7	8
616	Barometric Pressure		Gage Status	*****																											
			Data Collected	*****																											
			Analog Record	*****																											
604	Precipitation		Gage Status	*****																											
			Data Collected	*****																											
624	Air Temperature		Gage Status	*****																											
			Data Collected	*****																											
932	Anemometer at seaward end of pier Elevation 19 m (NGVD)		Gage Status	*****																											
			Data Collected	*****																											
645	Baylor staff at station 7+80 on FRF pier	see Figure 7	Gage Status	*****																											
			Data Collected	*****																											
625	Baylor staff at station 18+60 on FRF pier	see Figure 7	Gage Status	*****																											
			Data Collected	*****																											
111	Pressure gage 309 m north of FRF pier (0.9 km offshore)	Approx. 7.8 m NGVD	Gage Status	*****																											
			Data Collected	*****																											
630	Waverider buoy 6.0 km offshore	Approx. 23 m NGVD	Gage Status	----- Gage Inoperative ----- / *****																											
			Data Collected	----- / *****																											
519	Current meter 320 m north of FRF pier (0.9 km offshore)	see Figure 7	Gage Status	*****																											
			Data Collected	*****																											
865-1370	NOAA tide station at seaward end of FRF pier		Gage Status	*****																											
			Data Collected	*****																											
Supplemental Observations (daily oceanographic and meteorological observations)			Daily observation	// / * * * * / * * * / * * * * * / * * * / / / / * *																											

Gage Status	Daily Observation	Analog Record	Data Collected
Operational = *	Complete = *	Complete = *	All = *
Partial = /	Partial = /	Partial = /	Partial = /
Non-Operational = -	None = -	None = -	None = -

True North

- Pier Building at 0+40 to 1+00
- Anemometer at 0+70
- 12 Inch Rain Gage at 0+30
- Instrument Shelter at 0+40

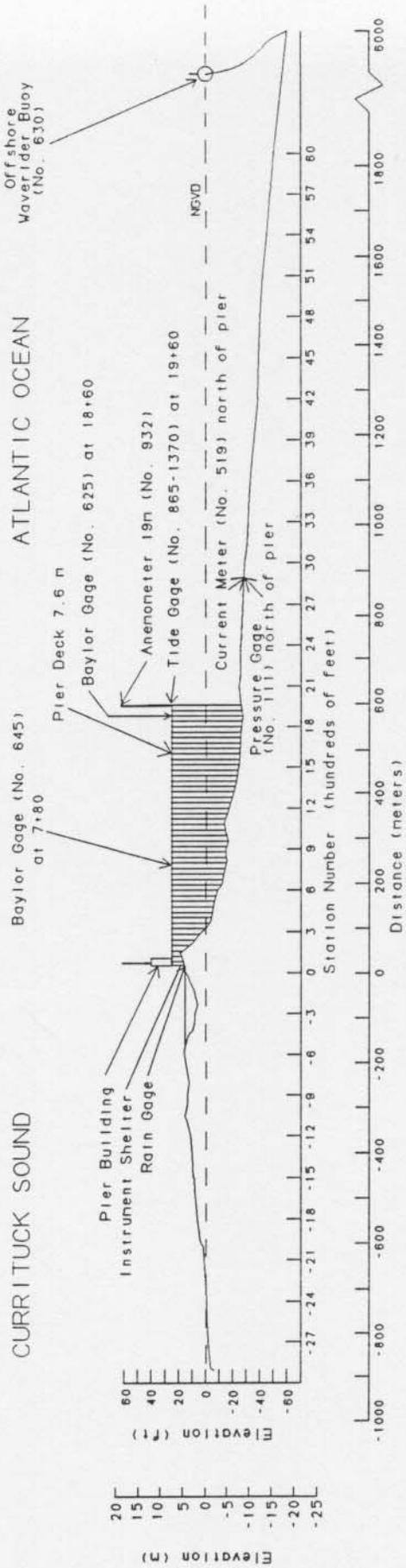
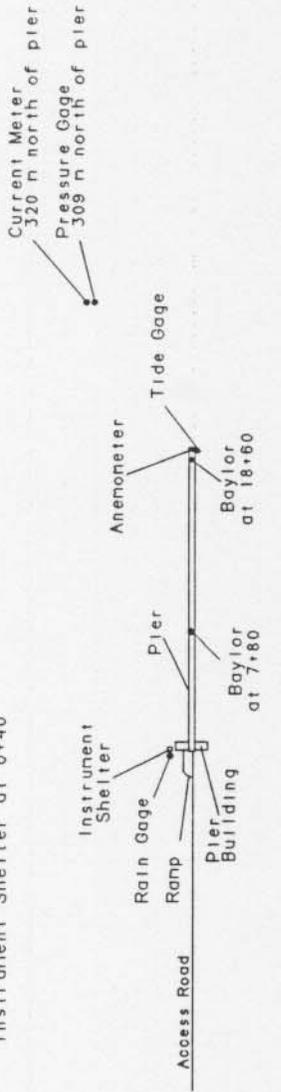


Figure 2. Instrument locations at FRF (all elevations from NGVD, all distances from FRF baseline).

PART II: METEOROLOGICAL DATA

A variety of instruments have been installed at the FRF (Figure 2) to monitor the meteorological conditions. The data presented in Table 2 are collected and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750. For each instrument identified in Table 1 as having analog outputs, chart records are obtained, a log is maintained and the records are stored for future reference.

Winds were measured at the end of the pier at an elevation of 19 m (Figure 2) using a Weather Measure Skyvane anemometer.

Monthly resultant wind speeds and directions are determined by vector averaging the data. Temperature and atmospheric pressure means are the average of the values presented for the month. Total precipitation is the sum for the month.

The following may be useful for converting the data in Table 2 to other frequently used units of measurement:

1. Millimeters (mm) to inches (in.) -
 $\text{mm} \times .03937 = \text{in.}$
2. Millibars (mb) to inches of mercury (in. Hg) -
 $\text{mb} \times 0.02953 = \text{in. Hg}$
3. Degrees Celsius (C) to degrees Fahrenheit (F) -
 $(C \times 9/5) + 32 = F$
4. Meters per second (m/s) to knots (kn) -
 $\text{m/s} \times 1.943 = \text{kn}$

Table 2: Meteorological Data

Feb 1991						
Day	Hour	Wind Speed	Wind Direction	Temperature	Atm Pressure	Precipitation
		m/sec	deg TN	deg C	mb	mm
1	100	12	350	3.3	1030.4	0
	700	8	12	2.5	1034.8	0
	1300	3	26	5.4	1035.8	0
	1900	5	93	4.5	1037.2	0
2	100	3	83	5.6	1036.2	0
	700	2	39	6.2	1035.8	0
	1300	3	134	12.2	1032.1	0
	1900	5	183	10.2	1030.7	0
3	100	3	231	7.4	1029.4	0
	700	4	235	6.7	1028.7	0
	1300	5	245	14.8	1026.7	0
	1900	3	176	10.0	1025.3	0
4	100	4	225	7.9	1025.0	0
	700	6	241	6.8	1025.0	0
	1300	4	238	16.2	1024.0	0
	1900	4	169	11.0	1023.6	0
5	100	5	229	9.3	1023.0	0
	700	6	227	7.8	1022.6	0
	1300	2	136	13.8	1020.9	0
	1900	4	186	12.9	1021.3	0
6	100	5	221	10.8	1020.6	0
	700	4	227	10.5	1021.3	0
	1300	1	240	15.4	1020.6	0
	1900	3	181	12.6	1020.6	0
7	100	4	228	11.1	1018.2	0
	700	4	130	9.6	1015.9	0
	1300	6	193	13.4	1011.8	3
	1900	1	164	11.8	1010.8	0
8	100	7	5	10.0	1009.8	0
	700	14	356	8.0	1010.4	5
	1300	13	2	7.4	1010.1	0
	1900	10	354	7.6	1010.8	0
9	100	9	3	6.7	1009.4	0
	700	3	297	4.1	1010.1	0
	1300	11	351	8.3	1008.1	0
	1900	5	26	7.4	1008.1	0
10	100	4	299	5.4	1007.7	0
	700	6	328	4.7	1007.7	0
	1300	5	359	7.3	1007.7	0
	1900	3	7	6.3	1008.4	0
11	100	0		3.8	1008.7	0
	700	7	30	7.0	1010.1	0
	1300	8	359	6.4	1009.4	0
	1900	4	351	4.3	1011.1	0
12	100	12	342	2.8	1013.5	0
	700	13	328	-1.4	1018.6	0
	1300	9	348	1.8	1019.2	0
	1900	0		-1.4	1018.6	0
13	100	6	174	2.1	1015.5	0
	700	8	193	6.5	1011.1	0
	1300	9	208	14.2	1005.7	0
	1900	4	155	9.7	1002.0	0
14	100	9	211	11.4	993.8	0
	700	10	214	12.3	989.1	0
	1300	10	247	15.9	986.4	0
	1900	3	270	12.2	988.8	0
15	100	9	286	7.1	991.1	0
	700	7	274	3.9	993.8	0
	1300	8	278	4.0	993.5	0
	1900	12	285	1.0	999.9	0
16	100	13	293	-4.1	1008.1	0
	700	11	288	-6.7	1014.8	0
	1300	9	297	-2.3	1018.6	0
	1900	6	279	-1.9	1021.6	0

* electronic problems

(Continued)

(Sheet 1 of 2)

Table 2: Meteorological Data

Feb 1991

Day	Hour	Wind	Wind	Temperature	Atm	Precipitation
		Speed	Direction	deg C	Pressure	mm
		m/sec	deg TN		mb	
17	100	6	239	-0.8	1023.0	0
	700	9	230	0.4	1023.0	0
	1300	9	229	6.8	1021.3	0
	1900	6	204	7.4	1022.6	0
18	100	3	213	6.6	1024.3	0
	700	2	194	6.7	1025.7	0
	1300	3	165	10.0	1025.3	0
	1900	3	147	8.8	1025.0	0
19	100	7	184	12.7	1024.0	0
	700	7	190	13.4	1023.3	0
	1300	8	189	18.5	1021.9	0
	1900	9	181	16.5	1021.3	0
20	100	6	198	13.9	1020.3	0
	700	9	203	14.4	1018.2	0
	1300	7	231	18.7	1015.5	0
	1900	4	220	17.1	1016.2	0
21	100	5	10	10.8	1019.2	0
	700	6	25	9.6	1020.9	0
	1300	6	3	10.0	1020.3	0
	1900	1	246	10.2	1018.9	0
22	100	3	248	10.0	1016.2	0
	700	5	244	10.4	1014.2	0
	1300	5	234	16.1	1010.4	0
	1900	6	209	13.3	1004.0	0
23	100	11	21	9.7	1008.4	0
	700	14	9	6.0	1012.8	0
	1300	15	9	5.5	1013.8	0
	1900	14	15	4.2	1015.5	0
24	100	9	48	8.6	1014.2	0
	700	7	27	8.8	1013.1	0
	1300	10	341	8.4	1010.4	0
	1900	11	350	8.2	1008.4	0
25	100	10	335	7.4	1007.4	0
	700	6	347	7.1	1006.7	0
	1300	9	342	7.9	1006.7	0
	1900	5	11	7.1	1006.7	0
26	100	5	347	6.6	1005.0	0
	700	12	4	5.0	1005.4	0
	1300	11	342	4.3	1008.7	0
	1900	6	307	3.6	1010.1	0
27	100	8	293	1.6	1012.1	0
	700	5	284	0.2	1016.5	0
	1300	8	236	6.5	1016.9	0
	1900	3	235	5.9	1018.6	0
28	100	6	206	6.2	1020.3	0
	700	6	214	5.9	1023.3	0
	1300	6	188	14.4	1022.3	0
	1900	5	161	9.2	1021.9	0
		<u>Resultant</u>		<u>Mean</u>	<u>Mean</u>	<u>Total</u>
		2	296	7.9	1015.5	8

* electronic problems

(Sheet 2 of 2)

PART III: WAVE DATA

Wave data are collected from two Baylor staff gages (Gages 625 and 645), a pressure wave gage (Gage 111) and a Waverider buoy (Gage 630) as shown in Table 1 and Figure 2. The data are collected, analyzed, and stored on magnetic tape using a Digital Equipment Corporation VAX 11/750 programmed to sample the wave gages every 6 hr (more frequently during storms) beginning at 0100, 0700, 1300, and 1900 EST. The sampling rate is two times per second for four contiguous 34-min records.

Wave height H_{mo} is an energy-based statistic equal to four times the standard deviation of the sea surface elevations. Wave height reported from the pressure gage has been compensated for hydrodynamic attenuation using linear wave theory. Wave period is identified from the computation of a variance (energy) spectrum with 60 deg of freedom calculated from a 34-min record. Peak wave period T_p is defined as the period associated with the maximum energy in the spectrum. When this analysis is complete, the data are written to magnetic tape.

Table 3 presents the wave heights and periods for each wave record obtained at 6 hr intervals during the month. The monthly means and standard deviations from the means shown in Table 3 are average values computed from this data. Figure 3 is a time history of all H_{mo} and T_p values obtained for all gages.

Differences in wave periods between wave gages (Table 3 and Figure 3) may be the result of wave breaking, wave reformation, or the presence of multiple wave trains containing nearly equal energy.

Table 3: Wave Data

Feb 1991									
Day	Hour	645 Baylor at 7+80		625 Baylor at 18+60		111 Pressure Gage		630 Offshr Wvrdr	
		Hmo.m	T.sec	Hmo.m	T.sec	Hmo.m	T.sec	Hmo.m	T.sec
1	0100	1.07	6.74	1.52	6.56	1.59	6.56		
	0700	1.18	6.40	1.14	6.92	1.17	7.31		
	1300	0.68	5.95	0.86	6.56	0.85	6.74		
	1900	0.69	5.33	0.78	5.95	0.78	6.40		
2	0100	0.44	2.81	0.62	6.40	0.63	9.48		
	0700	0.42	4.92	0.59	9.85	0.61	9.14		
	1300	0.33	10.67	0.51	9.48	0.55	9.48		
	1900	0.22	10.24	0.52	9.85	0.55	9.85		
3	0100	0.18	9.85	0.49	10.67	0.50	10.67		
	0700	0.17	10.24	0.48	9.14	0.50	9.85		
	1300	0.18	9.85	0.44	9.85	0.49	10.24		
	1900	0.25	10.24	0.49	9.85	0.52	9.48		
4	0100	0.25	10.24	0.46	9.85	0.48	9.85		
	0700	0.22	10.24	0.44	9.48	0.44	9.14		
	1300	0.15	9.85	0.36	9.48	0.43	9.85		
	1900	0.22	10.67	0.38	8.53	0.40	8.83		
5	0100	0.22	9.14	0.38	8.83	0.45	8.83		
	0700	0.18	10.24	0.43	9.48	0.41	8.83		
	1300	0.26	9.85	0.45	9.14	0.47	8.53		
	1900	0.14	10.67	0.49	8.83	0.50	9.14		
6	0100	0.32	9.14	0.59	9.14	0.63	9.14		
	0700	0.18	9.14	0.60	8.83	0.59	8.53		
	1300	0.33	8.83	0.60	8.83	0.57	9.14		
	1900	0.19	8.83	0.54	8.83	0.56	8.53		
7	0100	0.29	8.83	0.50	8.83	0.53	8.26		
	0700	0.17	8.83	0.47	8.26	0.50	8.83		
	1300	0.27	8.83	0.53	8.53	0.54	8.53		
	1900	0.24	8.26	0.51	8.83	0.55	8.53		
8	0100	0.49	6.92	0.62	8.83	0.69	8.83		
	0700	1.53	5.33	1.49	5.33	1.68	5.45		
	1300	1.45	6.56	1.84	6.40	2.06	6.74		
	1900	1.39	7.31	1.52	7.53	1.60	7.53		
9	0100	1.28	6.92	1.33	9.14	1.37	8.83		
	0700	1.00	6.74	1.15	8.83	1.15	8.26		
	1300	1.31	5.22	1.21	8.53	1.37	7.76		
	1900	0.94	4.66	0.94	6.92	1.03	8.53		
10	0100	0.64	5.33	0.76	7.76	0.74	8.26		
	0700	0.49	7.76	0.65	8.83	0.74	7.76		
	1300	0.77	4.49	0.77	7.53	0.86	8.83		
	1900	0.67	4.92	0.65	8.83	0.68	8.53		
11	0100	0.51	4.74	0.51	8.83	0.56	7.53		
	0700	0.54	3.08	0.61	9.14	0.47	8.83		
	1300	0.78	3.94	0.80	4.34	0.71	3.82		
	1900	0.54	4.49	0.61	6.09	0.65	6.74		
12	0100	1.12	4.74	0.92	4.66	0.97	4.83		
	0700	1.45	6.56	1.45	6.09	1.55	6.40		
	1300	1.22	6.56	1.14	6.40	1.23	6.40		
	1900	1.04	7.53	0.96	7.53	0.99	7.11		
13	0100	0.51	6.09	0.68	8.53	0.73	8.26		
	0700	0.34	8.26	0.52	8.26	0.52	8.53		
	1300	0.31	2.54	0.34	12.19	0.36	8.00		
	1900	0.23	12.19	0.29	9.48	0.29	9.14		
14	0100	0.18	2.39	0.39	9.14	0.37	8.83		
	0700	0.47	9.85	0.61	9.48	0.67	8.26		
	1300	0.34	12.19	0.62	11.13	0.69	11.64		
	1900	0.41	10.67	0.59	10.67	0.65	10.67		
15	0100	0.28	12.19	0.58	9.85	0.60	9.85		
	0700	0.26	12.19	0.41	11.64	0.47	11.64		
	1300	0.28	11.64	0.44	10.67	0.45	10.67		
	1900	0.63	5.12	0.74	4.83	0.78	4.92		
16	0100	1.04	5.57	0.79	5.57	0.94	4.92		
	0700	0.91	5.22	0.88	5.02	0.92	4.92		
	1300	1.04	5.45	0.79	5.57	0.85	5.12		
	1900	0.81	5.95	0.67	6.24	0.74	6.24		

Gage
Inoperative

* Electronic problems

(Continued)

Table 3: Wave Data

Feb 1991

Day	Hour	645		625		111		630	
		Baylor at 7+80 Hmo.m	T.sec	Baylor at 18+60 Hmo.m	T.sec	Pressure Gage Hmo.m	T.sec	Offshsr Hmo.m	Wvrdr T.sec
17	0100	0.48	4.83	0.41	12.19	0.45	12.80		
	0700	0.23	12.80	0.27	11.64	0.33	11.64		
	1300	0.17	16.00	0.29	12.19	0.28	10.67		
	1900	0.34	3.61	0.33	12.80	0.30	12.19		
18	0100	0.24	15.06	0.31	13.47	0.33	13.47		
	0700	0.21	14.22	0.27	12.80	0.30	11.64		
	1300	0.23	15.06	0.33	14.22	0.31	12.80		
	1900	0.22	12.19	0.30	12.80	0.39	12.80		
19	0100	0.23	12.80	0.40	12.80	0.37	12.80		
	0700	0.25	12.80	0.45	12.19	0.47	5.95		
	1300	0.30	14.22	0.46	12.80	0.47	5.57		
	1900	0.30	12.19	0.45	11.64	0.46	5.82		
20	0100	0.34	4.57	0.38	5.82	0.43	6.09		
	0700	0.36	6.09	0.43	5.82	0.47	6.24		
	1300	0.22	3.82	0.42	6.74	0.43	7.11		
	1900	0.39	3.88	0.40	6.40	0.40	6.74		
21	0100	0.28	4.66	0.38	6.92	0.39	6.92		
	0700	0.51	3.33	0.67	4.13	0.66	4.49		
	1300	0.63	4.20	0.80	5.82	0.76	4.49		
	1900	0.51	4.00	0.66	8.53	0.62	5.95		
22	0100	0.46	8.83	0.66	6.24	0.71	8.83		
	0700	0.40	5.22	0.55	8.83	0.59	8.83		
	1300	0.29	9.85	0.46	9.14	0.48	9.48		
	1900	0.25	9.48	0.36	9.85	0.36	8.83	0.46	9.14
23	0100	0.61	3.20	0.58	3.46	0.49	3.56	0.78	3.46
	0700	1.22	7.11	2.20	6.92	2.44	6.92	2.63	6.74
	1300	1.42	6.40	1.89	6.92	2.21	6.40	2.36	6.56
	1900	1.19	7.31	2.30	7.53	2.38	6.92	2.75	7.11
24	0100	1.40	7.11	1.66	6.24	1.79	6.74	2.10	6.40
	0700	1.21	6.40	1.42	7.53	1.38	6.92	1.56	5.57
	1300	1.25	6.56	1.39	7.31	1.47	7.11	1.65	7.11
	1900	1.30	6.74	1.78	8.83	1.89	8.83	2.05	9.14
25	0100	1.28	8.83	1.53	8.83	1.71	8.83	1.83	9.14
	0700	1.05	8.83	1.21	8.83	1.39	8.83	1.51	8.83
	1300	1.14	7.11	1.22	8.00	1.24	7.11	1.41	8.00
	1900	1.01	6.92	1.10	7.76	1.21	7.31	1.24	7.31
26	0100	0.89	7.76	1.09	7.76	1.12	8.00	1.05	7.31
	0700	1.31	4.92	1.32	5.12	1.48	4.74	1.54	5.12
	1300	1.30	6.24	1.34	6.56	1.48	6.09	1.68	6.09
	1900	1.10	5.82	1.01	6.09	1.14	5.02	1.32	5.82
27	0100	0.72	5.33	0.76	7.76	0.79	6.92	1.03	7.53
	0700	0.81	5.69	0.76	8.26	0.88	8.26	1.00	5.82
	1300	0.64	5.45	0.58	8.53	0.63	8.00	0.71	7.53
	1900	0.40	5.57	0.43	9.48	0.48	9.14	0.51	8.26
28	0100	0.37	3.71	0.38	9.14	0.40	8.83	0.59	9.14
	0700	0.26	9.85	0.32	9.48	0.35	8.83	0.51	9.48
	1300	0.20	10.67	0.35	9.48	0.36	9.48	0.43	9.48
	1900	0.36	10.67	0.49	10.24	0.47	10.67	0.58	10.67
	Mean	0.60	7.71	0.74	8.50	0.78	8.20	1.33	7.47
	Std dev	0.41	3.08	0.44	2.19	0.48	2.07	0.68	1.64

* Electronic problems

(Sheet 2 of 2)

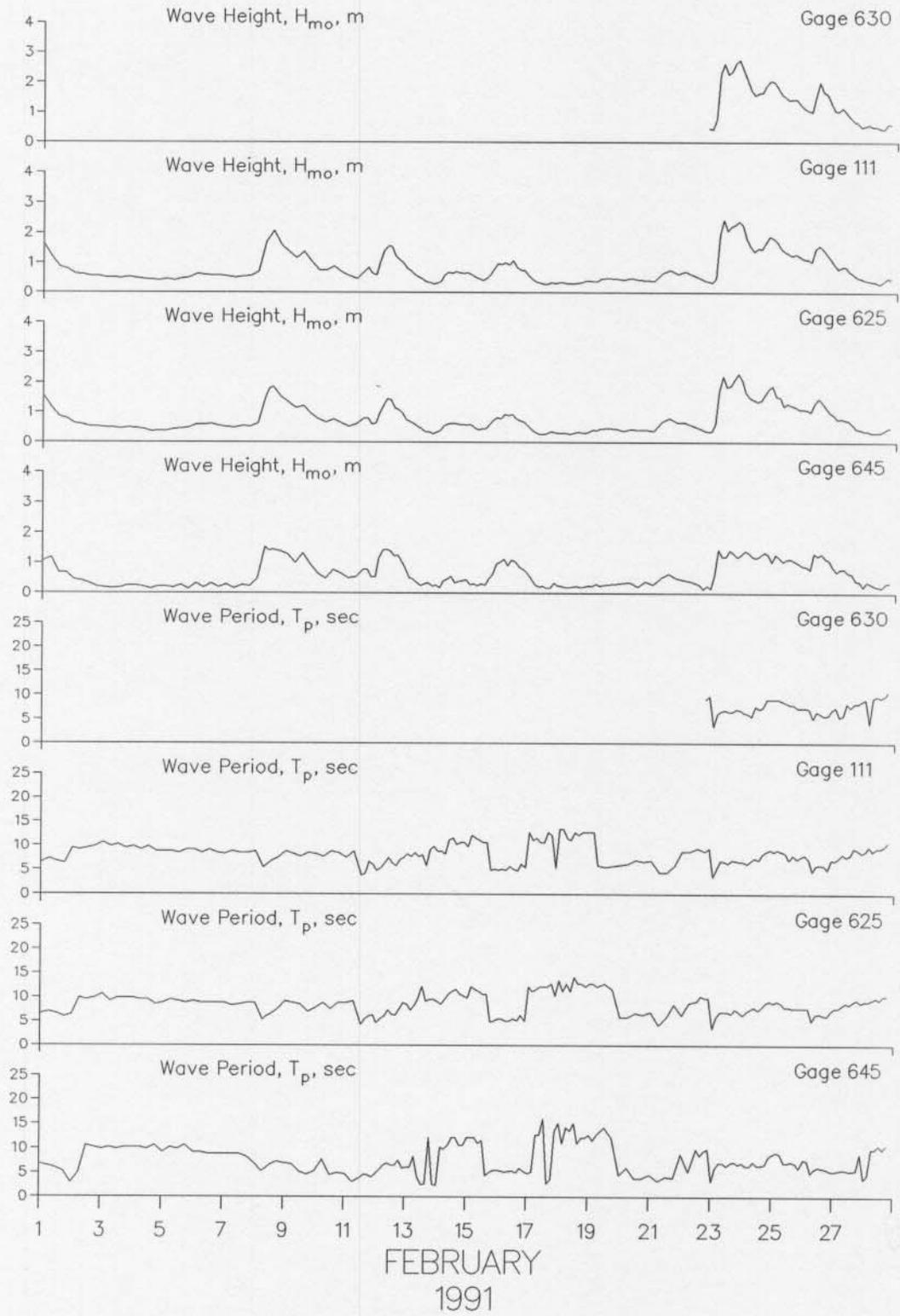


Figure 3. Time history of wave heights and periods

PART IV: CURRENT DATA

Current data (Table 4) are collected from a Marsh-McBirney electromagnetic biaxial current meter (Table 1 and Figure 2) and by visually observing the movement of dye on the water surface in the surf and at the seaward end of the pier, as well as 500 m updrift of the pier 12 m offshore.

Since the shoreline orientation is approximately N20W, longshore currents flow either toward 340 deg (i.e. northward) or toward 160 deg (i.e. southward). Similarly, cross-shore currents are either onshore (westward) or offshore (eastward).

All current speeds are given in centimeters per second (cm/sec). Resultant speeds and directions are determined by vector averaging the data.

Table 4: Current Data
Feb 1991

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed
1	0100	-Along Cross Result								28	S
										9	off
										29	142
1	0700	-Along Cross Result	20 6 21	S on 177					12	S	
					no observation		North			11	S
										4	off
										12	140
1	1300	-Along Cross Result								6	S
										4	off
										7	126
1	1900	-Along Cross Result								9	N
										3	on
										9	322
2	0100	-Along Cross Result								5	N
										1	off
										5	351
2	0700	-Along Cross Result	23 5 23	N on 329	132	10 0 10	N 340		no observation	9 4 10	N on 316
2	1300	-Along Cross Result								0 2 2	 off 70
2	1900	-Along Cross Result								13 6 14	N on 315
3	0100	-Along Cross Result								0 1 1	 off 70
3	0700	-Along Cross Result	24 0 24	N 340	140	16 6 17	N off 359		no observation	16 4 16	N on 326
3	1300	-Along Cross Result								6 3 7	N on 313
3	1900	-Along Cross Result								12 8 14	N on 306
4	0100	-Along Cross Result								7 4 8	N on 310
4	0700	-Along Cross Result	20 10 23	N off 7	140	14 6 15	N off 4		South 6 N	12 5 13	N on 317
4	1300	-Along Cross Result								7 4 8	N on 310
4	1900	-Along Cross Result								8 1 8	N on 333
5	0100	-Along Cross Result								4 0 4	S 160
5	0700	-Along Cross Result	0 10 10	 off 70	140	20 11 23	S off 131		North 5 S	5 1 5	S off 149
5	1300	-Along Cross Result								10 2 10	S off 149
5	1900	-Along Cross Result								16 4 16	S off 146

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1991

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir
6	0100	Along Cross Result									6 0 6	S 160
6	0700	Along Cross Result	15 5 16	S on 177	128	22 13 25	S off 129	North	9	S	8 1 8	S off 153
6	1300	Along Cross Result									8 2 8	S off 146
6	1900	Along Cross Result									9 1 9	S off 154
7	0100	Along Cross Result									6 3 7	S off 133
7	0700	Along Cross Result	10 0 10	N 340	140	17 0 17	N 340	South	10	N	10 0 10	S 160
7	1300	Along Cross Result									9 1 9	S off 154
7	1900	Along Cross Result									18 7 19	S off 139
8	0100	Along Cross Result									10 1 10	S off 154
8	0700	Along Cross Result			no observations were made						48 17 51	S off 140
8	1300	Along Cross Result									53 10 54	S off 149
8	1900	Along Cross Result									31 1 31	S off 158
9	0100	Along Cross Result									31 7 32	S off 147
9	0700	Along Cross Result	87 0 87	S 160	165	68 0 68	S 160	North	46	S	10 2 10	S off 149
9	1300	Along Cross Result									38 5 38	S off 153
9	1900	Along Cross Result									14 6 15	S off 137
10	0100	Along Cross Result									19 3 19	S off 151
10	0700	Along Cross Result	30 2 31	S off 157	152	24 7 25	S off 143	North	10	S	20 2 20	S off 154
10	1300	Along Cross Result									26 9 28	S off 141
10	1900	Along Cross Result									26 5 26	S off 149

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1991

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519			
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Location	Speed	Dir	Speed	Dir	
11	0100	Along Cross Result									20 6 21	S off 143	
11	0700	Along Cross Result	20 6 21	S on 177	140	24 7 25	S on 177	North	10	S	16 7 17	S off 136	
11	1300	Along Cross Result									16 7 17	S off 136	
11	1900	Along Cross Result									19 6 20	S off 142	
12	0100	Along Cross Result									34 10 35	S off 144	
12	0700	Along Cross Result			no observations were made							42 12 44	S off 144
12	1300	Along Cross Result									26 7 27	S off 145	
12	1900	Along Cross Result									9 4 10	S off 136	
13	0100	Along Cross Result									5 6 8	N on 290	
13	0700	Along Cross Result	61 12 62	N off 351	152	30 8 31	N off 354	South	15	N	13 9 16	N on 305	
13	1300	Along Cross Result									10 11 15	N on 292	
13	1900	Along Cross Result									4 4 6	N on 295	
14	0100	Along Cross Result									0 5 5	on 250	
14	0700	Along Cross Result	14 17 22	N off 31	128	41 12 42	N off 357	South	8	N	8 8 11	N on 295	
14	1300	Along Cross Result									10 7 12	N on 305	
14	1900	Along Cross Result									4 3 5	N on 303	
15	0100	Along Cross Result									1 1 1	N off 25	
15	0700	Along Cross Result	0 14 14	off 70	140	9 2 10	S off 146	North	20	S	11 3 11	N on 325	
15	1300	Along Cross Result									3 1 3	N on 322	
15	1900	Along Cross Result									9 3 9	S off 142	

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1991

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface) Speed	Dir	Dye at Mid-Surf Zone (surface) Distance from Baseline (m)	Speed	Dir	Dye 12m offshore (surface) Location	Speed	Dir	Speed
16	0100	-Along Cross Result								19	S
										4	off
										19	148
16	0700	-Along Cross Result	61	S		0				6	S
			3	off	158	0		North	3	0	
			61	157		0	0			6	160
16	1300	-Along Cross Result								9	S
										5	off
										10	131
16	1900	-Along Cross Result								4	N
										1	off
										4	354
17	0100	-Along Cross Result								7	N
										3	on
										8	317
17	0700	-Along Cross Result	14	N		11	N			20	N
			8	off	152	3	off	South	15	7	on
			16	11		12	357			21	321
17	1300	-Along Cross Result								17	N
										6	on
										18	321
17	1900	-Along Cross Result								11	N
										4	on
										12	320
18	0100	-Along Cross Result								2	N
										3	off
										4	36
18	0700	-Along Cross Result	51	N		11	N			7	N
			3	off	140	2	off	South	6	8	on
			51	343		11	349			11	291
18	1300	-Along Cross Result								1	S
										1	on
										1	205
18	1900	-Along Cross Result								5	N
										4	on
										6	301
19	0100	-Along Cross Result								4	S
										1	off
										4	146
19	0700	-Along Cross Result	29	N		55	N			1	N
			4	off	140	8	off	no observation		2	on
			29	349		56	349			2	277
19	1300	-Along Cross Result								4	S
										1	on
										4	174
19	1900	-Along Cross Result								10	N
										5	on
										11	313
20	0100	-Along Cross Result								6	N
										4	on
										7	306
20	0700	-Along Cross Result	51	N		30	N			11	N
			8	off	152	5	off	South	25	7	on
			51	349		31	349			13	308
20	1300	-Along Cross Result								8	N
										5	on
										9	308
20	1900	-Along Cross Result								5	N
										5	on
										7	295

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

Table 4: Current Data (Continued)
Feb 1991

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements					Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519		
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)		Dye 12m offshore (surface)			Speed	Dir		
			Speed	Dir	Speed	Dir	Location	Speed	Dir	Speed	Dir		
21	0100	Along Cross Result									2 1 2	S off 133	
21	0700	Along Cross Result	24 18 30	S on 197	152	9 3 10	S on 177	North	15	S	5 2 5	S off 138	
21	1300	Along Cross Result									6 8 10	S off 107	
21	1900	Along Cross Result									4 4 6	N on 295	
22	0100	Along Cross Result									4 2 4	N on 313	
22	0700	Along Cross Result	41 6 41	S off 151	152	30 18 36	N off 11	South	12	S	9 10 13	N off 28	
22	1300	Along Cross Result									9 3 9	S off 142	
22	1900	Along Cross Result									6 4 7	S off 126	
23	0100	Along Cross Result									15 16 22	S off 113	
23	0700	Along Cross Result			no observations were made							44 16 47	S off 140
23	1300	Along Cross Result									42 13 44	S off 143	
23	1900	Along Cross Result									44 13 46	S off 144	
24	0100	Along Cross Result									25 5 25	S off 149	
24	0700	Along Cross Result	41 12 42	S on 177	165	61 3 61	S off 157	no observation			35 12 37	S off 141	
24	1300	Along Cross Result									26 5 26	S off 149	
24	1900	Along Cross Result									45 12 47	S off 145	
25	0100	Along Cross Result									39 14 41	S off 140	
25	0700	Along Cross Result	41 0 41	S 160	274	24 7 25	S off 143	no observation			25 11 27	S off 136	
25	1300	Along Cross Result									36 2 36	S off 157	
25	1900	Along Cross Result									25 12 28	S off 134	

KEY = All speeds in cm/sec
N = Northward, Shore parallel
S = Southward, Shore parallel
on = onshore off = offshore

Table 4: Current Data (Concluded)
Feb 1991

Day	Time	Alongshore Cross-shore Resultant	Pier Measurements				Beach Measurements (500m Updrift)			Current Meter 0.9 km Offshore Depth -5.6m (NGVD) ID #519	
			Dye at (579 m) (surface)		Dye at Mid-Surf Zone (surface) Distance from Baseline (m)		Dye 12m offshore (surface)			Speed	Dir
			Speed	Dir	Speed	Dir	Location	Speed	Dir	Speed	Dir
26	0100	-Along Cross Result								14 4 15	S off 144
26	0700	-Along Cross Result	61 3 61	S off 157	195	61 0 61	S off 160	no observation		38 13 40	S off 141
26	1300	-Along Cross Result								27 6 28	S off 147
26	1900	-Along Cross Result								29 8 30	S off 145
27	0100	-Along Cross Result								17 0 17	S off 160
27	0700	-Along Cross Result	30 9 32	S off 143	128	41 0 41	S off 160	North	23 S	19 5 20	S off 145
27	1300	-Along Cross Result								1 6 6	S on 241
27	1900	-Along Cross Result								2 3 4	S on 216
28	0100	-Along Cross Result								0 3 3	on 250
28	0700	-Along Cross Result	12 21 24	N off 40	128	12 6 14	N off 7	South	8 N	6 6 8	N on 295
28	1300	-Along Cross Result								6 8 10	N on 287
28	1900	-Along Cross Result								4 2 4	N off 7

KEY = All speeds in cm/sec
 N = Northward, Shore parallel
 S = Southward, Shore parallel
 on = onshore off = offshore

PART V: SUPPLEMENTAL OBSERVATIONS

Visual wave direction measurements (Table 5) of both the primary wave train (i.e. that having the larger wave heights) and the secondary wave train (which must be clearly distinguishable as a wave train separate from the primary waves but not surface chop or capillary waves) are taken daily at the seaward end of the pier. The direction of the primary wave train just north of the seaward end of the pier is also determined using a Raytheon Marine Pathfinder radar and measuring the alignment of the wave crests at approximately the same location as the visual measurements. The pier axis (considered perpendicular to the beach at the FRF) is orientated 70 deg east of true north; consequently, wave angles greater than 70 deg indicate that the waves were coming from the south side of the pier.

The width of the surf zone (seawardmost breaker position to shoreline) is determined from the pier deck.

Measurements of surface water temperature, density, and visibility are also taken daily at the seaward end of the pier. A jar along with a thermometer is lowered about 0.3 m into the water and allowed to remain for at least one minute. The jar is removed, the temperature read, and a hydrometer is used to determine the density. A Secchi disc is used to determine the surface visibility.

Table 5: Supplemental Observations

Feb 1991

Day	Time	Wave Approach Angle at Pier End deg from True N		Radar Wave Angle deg from True N	Width of Surf Zone, m	Water Characteristics at Pier End		
		Primary	Secondary			Temp., C	Density g/cc	Secchi Vis., m
1	0808	55	40		219	8.3	1.0235	2.7
2	0715	55	90		91	8.3	1.0236	3.4
3	0730	110		inoperative	7	8.3	1.0232	2.7
4	0835	none	visible		2	10.5	1.0246	1.8
5	0805	none	visible	65	3	11.1	1.0250	2.7
6	0810	55			136	8.9	1.0202	3.0
7	0830	none	visible		40	10.0	1.0205	2.4
8	0810	55		35	281	8.9	1.0194	1.5
9	0930	55		60	191	8.9	1.0206	1.5
10	0935	80	25		179	9.4	1.0220	1.5
11	0715	35		95	4	8.9	1.0201	2.7
12	0714	30	15	40	238	7.8	1.0194	0.9
13	0720	none	visible		5	8.9	1.0224	1.5
14	0745	none	visible		4	10.0	1.0244	2.7
15	0855	none	visible	100	2	9.4	1.0245	3.0
16	0915	15	355		241	7.8	1.0251	1.2
17	1005	none	visible		2	8.0	1.0249	3.4
18	1125	none	visible		10	8.3	1.0243	4.3
19	0857	105			6	10.0	1.0252	3.0
20	0710	30	10	inoperative	2	10.5	1.0251	2.7
21	0715	none	visible		112	11.1	1.0254	2.7
22	0810	none	visible		141	10.0	1.0212	2.7
23	0705	25		55	329	10.0	1.0232	2.4
24	1005	50	70		233	8.3	1.0212	1.2
25	0810	50	70		194	8.6	1.0202	1.5
26	0815	30		50	245	8.3	1.0211	0.3
27	0810	none	visible	50	51	7.8	1.0224	2.1
28	0806	none	visible		2	8.9	1.0230	1.2

PART VI: WATER LEVELS

Since 1978, the National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS) has operated a primary tide station (No. 865-1370) at the seaward end of the FRF pier. A Leupold-Stevens digital recording float-type tide gage is used to collect instantaneous water level data every 6 minutes throughout the month.

The variation in water level during the month is shown in Figure 4 along with a list of mean and extreme values. This presentation is useful in identifying effects of both meteorological and astronomical forces on the open coast water level.

Table 6 contains the time at the center of each 12.42-hr tidal cycle and the range, high, low, and mean water levels during each tidal cycle.

FRF Tide Heights

Feb 1991

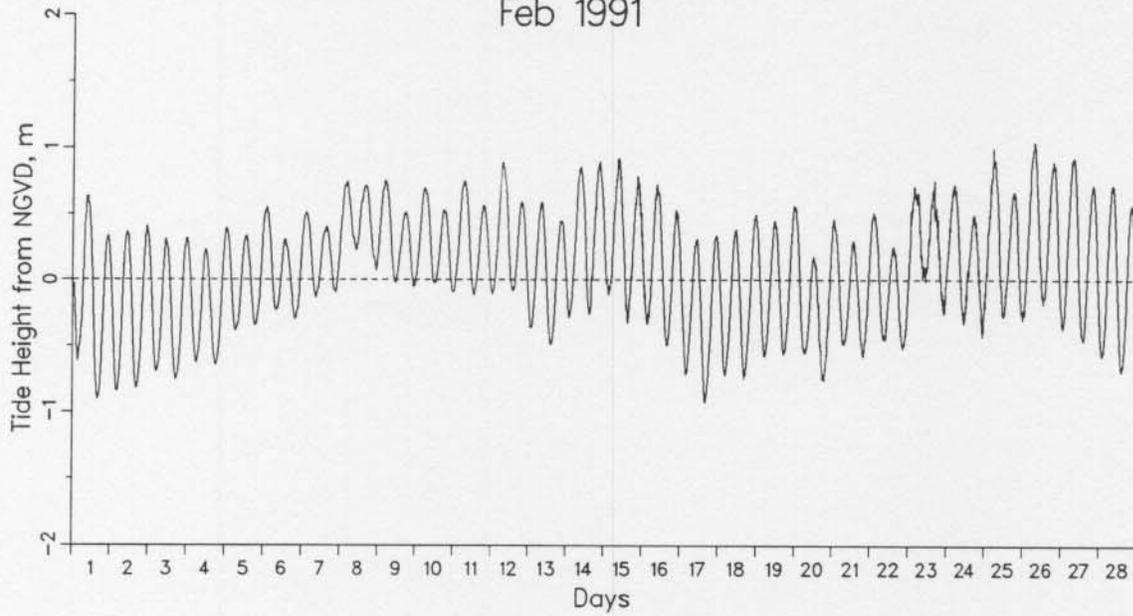


Figure 4. Water level time history

Monthly Water Levels, m NGVD

Extreme Low = -0.93 on day 17 at 1436 EST
Extreme High = 1.04 on day 26 at 530 EST
Monthly Mean = 0.08
Mean Low = -0.41
Mean High = 0.56
Mean Range = 0.97

Table 6: Water Levels,m NGVD

		Feb 1991			
Mid-Cycle		Low	High	Mean	Range
Day	Time				
1	554	-0.61	0.64	0.01	1.25
1	1819	-0.90	0.34	-0.27	1.24
2	644	-0.84	0.36	-0.22	1.20
2	1909	-0.82	0.41	-0.21	1.23
3	734	-0.69	0.31	-0.21	1.01
3	2000	-0.76	0.32	-0.22	1.07
4	825	-0.63	0.23	-0.21	0.86
4	2050	-0.64	0.39	-0.12	1.04
5	915	-0.38	0.34	-0.03	0.72
5	2140	-0.34	0.55	0.11	0.89
6	1006	-0.23	0.31	0.03	0.54
6	2231	-0.30	0.51	0.13	0.81
7	1056	-0.13	0.40	0.15	0.53
7	2321	-0.09	0.74	0.34	0.84
8	1146	0.23	0.71	0.48	0.48
9	12	0.08	0.76	0.43	0.68
9	1237	-0.02	0.51	0.26	0.53
10	102	-0.05	0.70	0.33	0.75
10	1327	-0.03	0.53	0.25	0.56
11	152	-0.09	0.75	0.33	0.84
11	1418	-0.11	0.57	0.23	0.68
12	243	-0.10	0.89	0.38	0.99
12	1508	-0.08	0.59	0.24	0.67
13	333	-0.36	0.59	0.11	0.95
13	1558	-0.48	0.45	0.00	0.94
14	424	-0.29	0.86	0.30	1.14
14	1649	-0.26	0.89	0.35	1.15
15	514	-0.11	0.92	0.37	1.04
15	1739	-0.33	0.78	0.23	1.11
16	604	-0.33	0.73	0.18	1.06
16	1829	-0.50	0.53	-0.02	1.03
17	655	-0.71	0.31	-0.22	1.03
17	1920	-0.93	0.34	-0.25	1.27
18	745	-0.72	0.38	-0.18	1.10
18	2010	-0.75	0.50	-0.09	1.25
19	835	-0.57	0.45	-0.07	1.02
19	2101	-0.56	0.56	0.02	1.13
20	926	-0.66	0.18	-0.24	0.84
20	2151	-0.76	0.47	-0.11	1.23
21	1016	-0.49	0.30	-0.13	0.79
21	2241	-0.58	0.51	0.01	1.09
22	1107	-0.46	0.26	-0.11	0.71
22	2332	-0.52	0.71	0.15	1.24
23	1157	-0.01	0.76	0.31	0.77
24	22	-0.26	0.73	0.27	0.99
24	1247	-0.33	0.50	0.10	0.83
25	113	-0.43	0.99	0.32	1.42
25	1338	-0.28	0.67	0.20	0.95
26	203	-0.30	1.04	0.36	1.34
26	1428	-0.18	0.89	0.35	1.08
27	253	-0.37	0.93	0.29	1.30
27	1519	-0.46	0.72	0.13	1.18
28	344	-0.58	0.72	0.06	1.30
28	1609	-0.69	0.57	-0.05	1.26
29	434	-0.59	-0.17	-0.38	0.41

PART VII: NEARSHORE PROFILES

A. Nearshore Profiles. In order to document profile response away from the pier, surveys of four profile lines extending 900 to 1,000 m from shore and located 489 and 581 m north and 517 and 608 m south of the FRF pier are conducted bi-weekly, after storms, and during more complete bathymetric surveys.

These profiles are obtained using the CRAB-Geodimeter surveying system; a Geodimeter 140-T self-tracking, electronic theodolite, distance meter, in combination with the Coastal Research Amphibious Buggy (CRAB), a 10.7 m high, self-powered, mobile tripod on wheels.

Figure 5 shows the last survey in January and the two surveys in February on profile line 188, located 517 m south of the pier. The only significant change was a 40 m shoreward migration of the nearshore bar (200 - 400 m). Only minor changes are visible on the remainder of the profile.

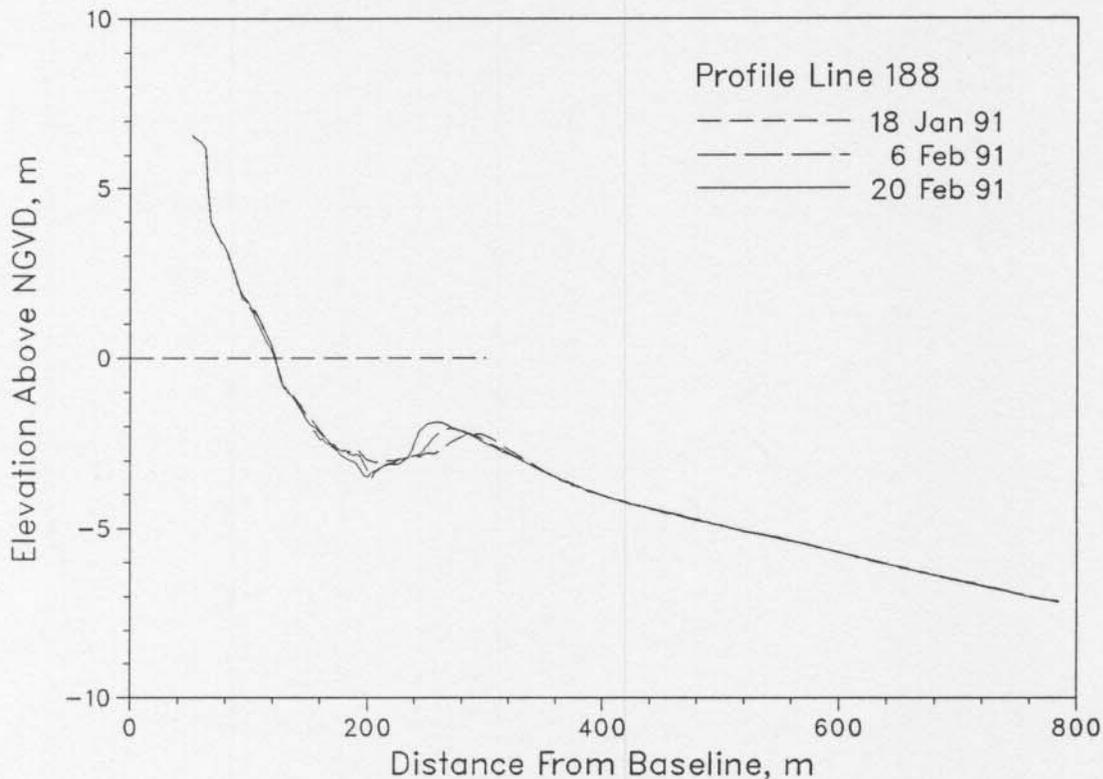


Figure 5. Monthly CRAB profiles on profile 188 - 517 m south of pier.

The profile envelope (Figure 6) reflects the maximum changes that occurred on the profile during 1991.

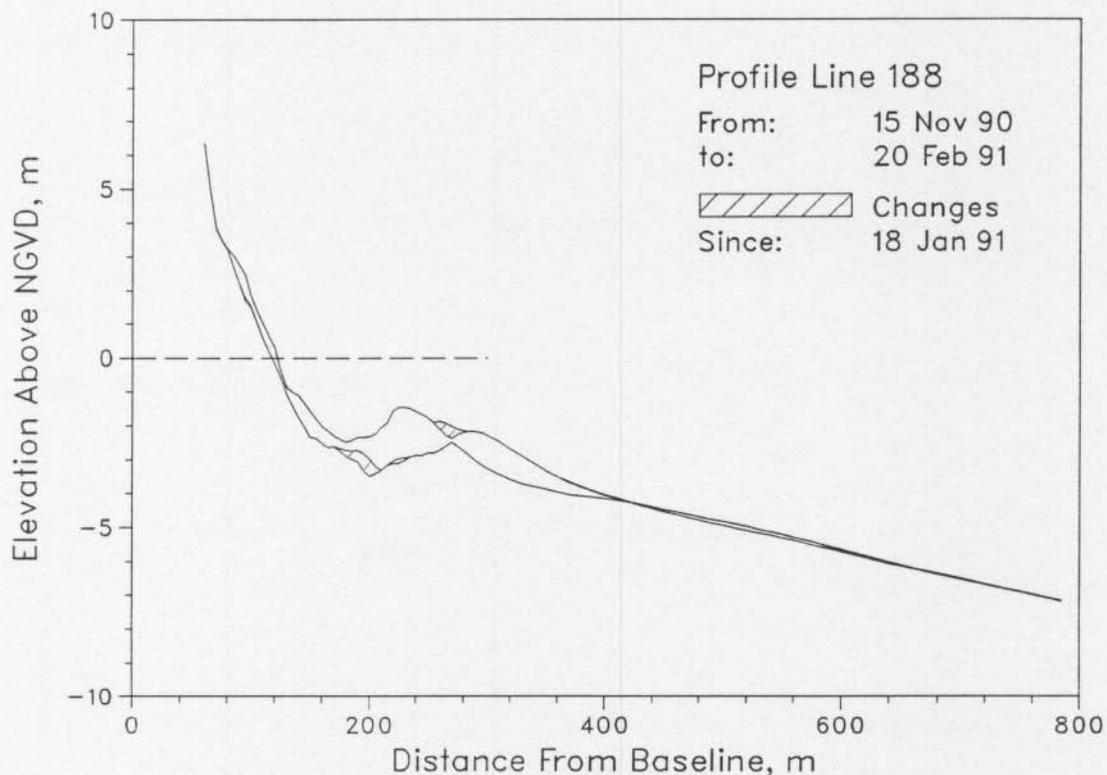


Figure 6. CRAB profile envelope - profile 188.

B. Bathymetry. Figure 7 includes a two- and three-dimensional contour map and a change plot derived from the bathymetric survey on 15 January and is included for reference. Wide contour lines on the change diagram represent eroded areas; thin lines indicate deposition.

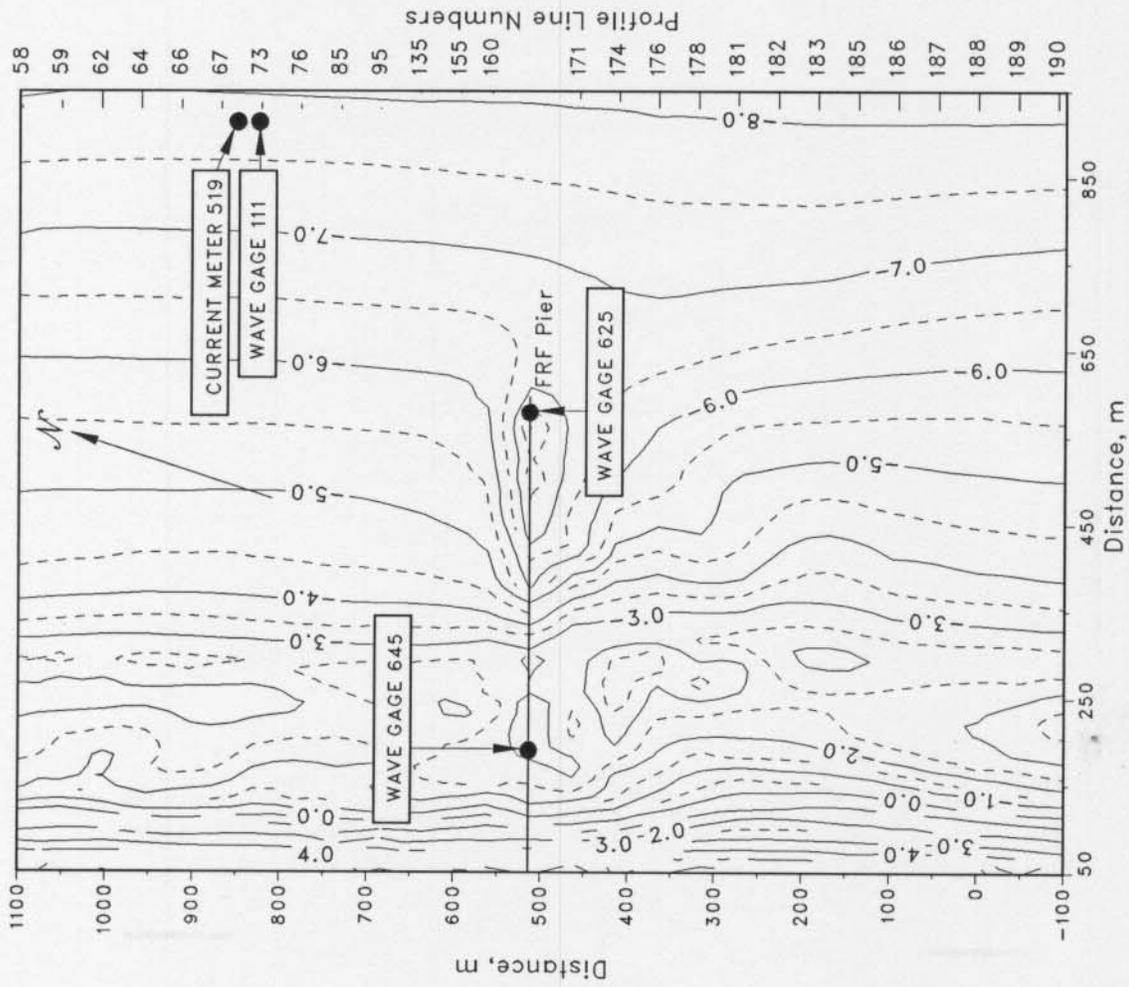
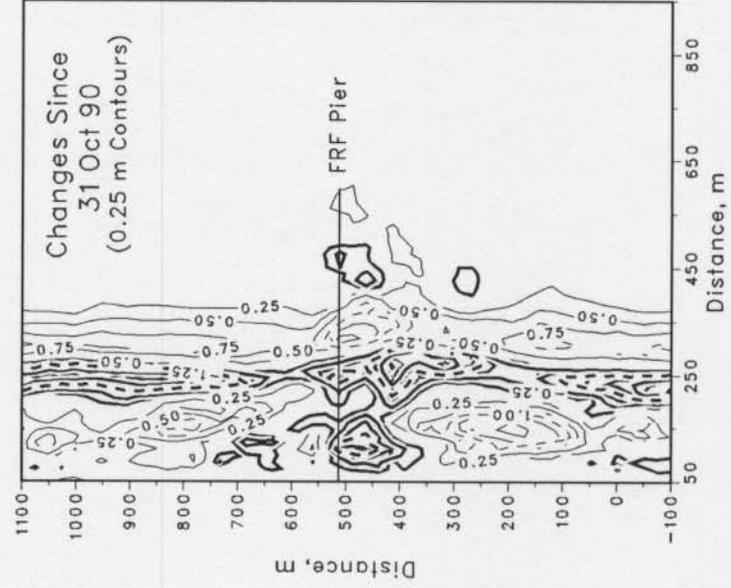
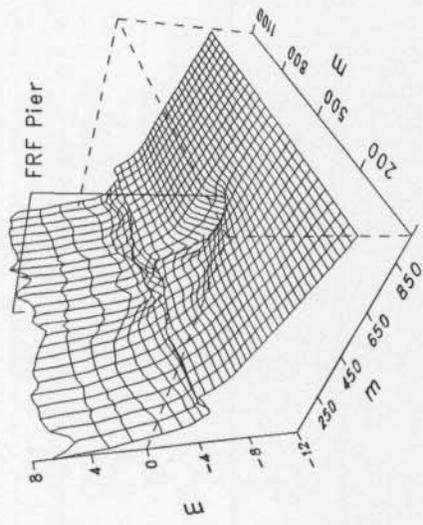


Figure 8. FRF bathymetry 18 Jan 91 depths relative to NGVD

PART VIII. SPECIAL EVENTS

A. Storm Data Collection. The following list identifies times when the significant wave height at the seaward end of the pier (i.e. as measured near the end of the pier) exceeded 2 m and four contiguous 34 minute wave records were obtained every three hours:

<u>Start</u>	<u>End</u>
23 Feb (0542)	23 Feb (2200)

B. Storm Synopsis.

23 February - Developing in the Gulf of Mexico off Texas on 20 February this weak storm slowly moved across the southern U.S. being located over South Carolina on 23 February and moving offshore the following day. Peak winds (from the north-northeast) approached 16 m/s at 0508 EST on 23 February. The maximum H_{mo} (at gage 625), which was recorded later that day at 1900 EST, reached 2.30 m ($T_p = 7.53$ sec). The minimum atmospheric pressure of 1003.4 mb occurred at 1708 EST on 22 February. There was no precipitation at the FRF from this storm.

Distribution List

Government Agencies:

OCE	U.S. Geological Survey
BERH	U.S. National Park Service
NAO	U.S. Naval Academy
NASA/Wallops Flight Center	U.S. Naval Civil Eng. Lab
NOAA (NOS, NWS)	U.S. Naval Fac. Eng. Com.
SAD	U.S. Naval Oceanographic Off.
SAW	U.S. Naval Research Lab

Colleges/Universities:

California Inst. of Tech.	Stockton State College
East Carolina University	University of Akron
Florida Inst. of Tech.	University of Delaware
Harvard University	University of Florida
Naval Post Graduate School	University of Maryland
NC State University	University of Miami
Old Dominion University	University of North Carolina
Oregon State University	University of N. Colorado
Prince George's College	University of Rhode Island
Rutgers University	University of Virginia
Scripps Inst. of Oceanography	Va. Inst. of Marine Science
Southern Illinois University	

Others:

City of Va. Beach, VA	MEC Systems Corporation
Coastal Barge Corporation	Moffatt & Nichol, Eng.
Coastal and Est. Res., Inc.	Offshore Coastal Technologies
Coastal Science & Eng., Inc.	Mr. Rowland
Dr. Galvin	Mr. Savage
GEOMET Tech., Inc.	Sea Port Supply Corp.
Greenhorne & O'Mara, Inc.	Shell Development
Dr. Hylton	Sherwood Industries
Mary Marr, Inc.	Mr. & Mrs. Valpey
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Masonite Corporation	SEASUN Power Systems

Foreign:

W. F. Baird & Asso. Coastal Engineers, Ltd (Canada)
Queen's University, Ontario (Canada)
Ministry of Construction, Coastal Division (Japan)
Norwegian Hydrodynamic Laboratories (Norway)
University of New South Wales (Australia)
University of Sydney (Australia)